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ABSTRACT

Research has suggested that memory performance may be related to the extent of stimulus processing during acquisition. To examine processing efficiency and processing deficiency differences between younger and older adults, four studies were conducted. In the first study, young and old adults rated word lists, manipulated for generation specific familiarity, and completed a free-recall test. Results showed that young adults recalled more words than older adults. However, on the word list, older adults did better than younger adults. In the second study, subjects rated word lists and completed a forced-recall test to investigate the role of individual differences in incidental learning. The results produced were identical to the first study. In addition, an effect of cardiovascular health status on unfamiliar materials was found. In the third study, subjects rated a single word list and completed individual difference measures of anxiety, intelligence, education, and mental activity. The results showed the existence of a difference between younger and older healthy adults, and that cardiovascular health status did effect performance for both unfamiliar and familiar words. Level of education and mental activity were positively correlated with performance. In the fourth study, subjects, varied by mental activity while holding educational level constant, rated word lists. The results showed that level of education was the important individual difference rather than mental activity. These findings suggest that age-related memory differences reflect a combination of inefficiency of processing and actual loss of processing capacity, both of which are modulated by individual difference variables. (BL)

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Age-Related Differences in Incidental Learning

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Terry R. Barrett, Chair
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In 1972 Craik and Lockhart proposed that memory performance is related to the extent of stimulus processing that is engaged in during acquisition. This hypothesis has come to be called the depth of processing hypothesis. These authors argued that stimulus processing could be viewed as a continuum from shallow (or nonsemantic) processing to deep (or semantic) coding. Performance on a later memory task is said to be a direct consequence of the depth of processing engaged in with deeper levels leading to higher performance.

One of the more interesting depth of processing studies was conducted by Eysenck in 1974. Eysenck hypothesized that the well documented age-related recall decrement might be due to differential depth of processing during acquisition. In order to investigate this hypothesis he tested younger and older adults in an incidental learning situation. Individuals were presented with a list of nouns, one at a time, and were asked to engage in either a nonsemantic or a semantic orienting task. Immediately after the last word was presented, Eysenck gave all his subjects a surprise free-recall test. the first slide shows the results he obtained on the recall test. There was no difference between younger and older adults when the orienting task was a nonsemantic one. On the other hand, there was a clear difference in favor of younger adults when subjects had engaged in a semantic orienting task.

I thought that this finding was a particularly important one. It seemed to me that using a semantic

orienting task in an incidental learning paradigm has a good deal of ecological validity. This situation appears analogous to the sort of situation in which adults learn a great deal of new information. Rather than sit and consciously memorize material, adults typically learn by processing meaning as new information is presented. Reading current magazines or the newspaper, watching television, and listening to the radio are just a few of the examples I have in mind.

It seemed to me that there were at least two ways of thinking about this age-related decrement. One hypothesis might be called the processing deficiency hypothesis. Deficiency refers to the idea that older adults are unable to process material as deeply as younger adults. This loss in processing ability could be due to a variety of factors including the presence of various diseases and/or the operation of a normal aging process. Another possibility is the processing efficiency hypothesis. Efficiency refers to the relative ease of processing at a given time. This hypothesis suggests that older adults may not be as efficient at semantic processing as younger adults in a given situation, but with more appropriate material or in different situations older adults might be as efficient, or even more efficient at semantic processing than younger adults. Likely sets of variables that might effect processing eficiency would be task and material variables.

As a research strategy, I decided to test the

hypothesis that Eysenck had demonstrated a processing efficiency difference between between younger and older adults rather than an actual loss of processing capacity. If that were true there ought to be situations in which older adults would show equal, if not more, efficient semantic processing than younger adults.

Mavis Wright and I (Barrett and Wright, 1981) designed an incidental learning situation that we thought might be conducive of extensive semantic processing by older adults. One variable we manipulated was word familiarity. It seemed obvious to us that very familiar words can be processed more fully than unfamiliar words. So we constructed two word lists that differed in generation specific familiarity. The two lists we used are shown in the next slide. The young list contained words rated as quite familiar by young adults but were rated as quite unfamiliar by older adults. The old list contained words familiar to older adults but generally rather unfamiliar to younger adults. The experiment consisted of four groups of subjects. Younger and older adults were exposed to either the young or the old word list.

Since the experimental procedures that we used in this study were the ones we used throughout this series of studies, let me spend a little time describing them to you. We did everything we could think of to make the experimental situation one in which older adults could show us what they were capable of doing. First of all, we did not test

individuals in our laboratory. Rather we tested all of the subjects in a room at their church or in their own home. We wanted the subjects to feel like they were on their own turf, so to speak. We hoped that this would reduce or eliminate any anxiety that subjects might feel when they are in an experimental situation. Young subjects were between the ages of 18 and 32 while older subjects ranged from 60 to 75 years of age. All of the subjects were given instructions concerning the rating tasks and were then given five practice words to rate. The rating tasks we used were a pleasantness rating task and a size rating task. The words were presented one at a time in an unpaced fashion. If, after 30 seconds, the subject had not yet made a rating, she was encouraged to do so. Immediately following the last rating, subjects were asked to count backwards from 100 for 1 minute. Each individual was then given a surprise free-recall test. The test lasted for 5 minutes. During the recall period, the subject was told to say all the words he could remember from the list he had just seen. The experimenter recorded the words to eliminate any shyness or anxiety about spelling deficiencies. Positive reinforcement was always given for each response, whether it happened to be correct or not. The whole idea behind establishing the situation was to make each subject as relaxed and comfortable as possible and to eliminate all time ressure.

This slide shows the mean number correct for the two groups on each of the two lists. For a monent, look at

performance on the young list. As you can see we were able to replicate the typical finding. Young people recalled more words than older adults. However, on the old list just the opposite occurred. Here the older people did better than the young adults. One obvious way to understand these results is to suggest that older adults are capable of effective semantic processing that can lead to recall every bit as high as that demonstrated by young adults. This notion suggests that one key to understanding recall differences is to pay close attention to the interaction between task variables and subject variables such as age. Further it suggests that age-related recall deficits may be more a ion function of problems in processing efficiency than in the actual loss of processing capacity. However, there was one other hypothesis that we thought might account for the present results. As a check, at the end of the experimental procedure we had all of our subjects rate the familiarity of the words they had seen. In general older adults rated the words as more familiar than did younger adults. That finding suggested to us that we may have biased the task too much in favor of older adults. In other words, older adults may really be deficient compared to young adults when it comes to semantically processing material for later recall. However that deficiency, in this study, is being masked by the familiarity bias in favor of older adults.

The second study in this series was conducted by Sandy

Watkins and myself. What we attempted to do in this experiment was to replicate the interaction between type of list and age of the subject when the familiarity was very carefully controlled. To do that I constructed familiarity norms (Barrett, 1983) on 400 words, 200 young words and 200 old words. Approximately 30 young and 30 older adults rated the familiarity of all 400 words. Once that was done we constructed a young list and an old list so that standardized familiarity means were exactly balanced. That meant that the familiarity difference between younger and older adults on each list was the same but reversed in each case.

It was in this experiment that I first began to look at the influence of individual difference variables on recall. I really did not want to simply replicate the first study using different materials. That seemed like a considerable bit of effort for not nearly enough payoff. In thinking about it, two things came to us. I got the idea to test for undue cautiousness in older adults during the recall test. Botwinick (1978) has cited a number of studies that demonstrate that older adults may avoid making errors by simply failing to respond. The way we got at cautiousness was by including a forced-recall test immediately after the free-recall test. In the forced test subjects were instructed to give us 25 words and were forced to continue until they had done so. Since there were only 14 words on each of the lists, the subject had no choice but to tell us

everything he knew about the word list plus generate 11 additional words.

Sandy suggested a second individual difference variable. It seemed to her that the issue of differential health status between younger and older people is one that is widely recognized but often given only lip service when aging research is conducted. For example Abrahams et al (1975) indicated that only 17 percent of psychological experiments reported in the Journal of Gerontology from 1963 to 1974 made any attempt to systematically control for the health of subjects. Obviously, failure to control for health status in cross-sectional aging research could produce effects that appear to be age-related but are really health-related. Since the most common chronic illness seems to be cardiovascular disease and since cardiovascular disease has already been related to deficits in reaction time and intellectial functioning, it seemed quite appropriate to use a procedure that would let us distinguish between older adults with indications of cardiovascular disease and those without such problems. We did that by asking each subject to tell us all of the prescription drugs that she was taking and to indicate the reason for taking the drug. The experimental procedure was generally the same as in the first experiment with the exception of including a forced- recall after the free-recall test.

The next slide shows the results of this study. One hypothesis that we can discard immediately has to do with

cautiousness. We thought that perhaps we would see a different pattern of effects on the forced-recall test compared to the free-recall test, particularly with older adults. As you can see, the forced-recall test produced results almost identical to that on the free-recall test. This suggested to us that, at least in this task, cautiousness was not a variable of importance in understanding age-related recall decrements.

OK, lets concentrate on the free-recall results. First of all you can see that we replicated the results of the first study. Young adults did better than older adults on the young list but older adults did better than younger adults on the old list. There was also an interaction between health status of the older adults and list. While there was virtually no difference on the old list between older adults with and without indications of cardiovascular disease, there was a recall difference on the young list in favor of the healthy older adults. Finally among the healthy adults there was a main effect of age. Collapsed across both lists younger adults showed higher recall than older adults.

As you can see, the the word familiarity manipulation again produced results consistent with the processing efficiency hypothesis. Given appropriate types of material, older adults can, and do, show superior semantic processing compared to younger adults. The effect of health status on unfamiliar materials, at first glance, seems most consistent

with the processing deficiency hypothesis. Older adults who do have a cardiovascular problem may well be suffering from some sort of generaly irreversible processing deficit that manifests itself in relatively difficult situations. Another possibility, however, is that the recall decrement observed with unfamiliar material reflects inefficient semantic processing. The inefficiency could be due to the kinds of drugs these adults are taking for their cardiovascular problems. Typical side effects of many of the drugs taken for heart disease include dizziness and disorientation. These effects typically disappear upon sessation of drug use. The final conclusion that we might draw from the current data concerns the interaction between list and age for only healthy adults. As you can see when the material is unfamiliar, younger and older adults recalled almost exactly the same amount. When the material was familiar, however, younger adults recalled more than older adults. The processing deficiency hypothesis seems best able to account for this effect. One of the things you might expect to happen if there is an actual processing deficiency is that there would be a ceiling on performance. In other words in the most advantageous situation, older adults would show somewhat reduced performance. At this point, then, we have indications that both the processing efficiency and the processing deficiency hypotheses may be appropriate.

In the next experiment Louanne Yarbro and I decided to

look more closely at the apparent ceiling on performance in the older population. We did this in two ways. First of all we used only a single word list. We selected words from my word familiarity norms so that collapsed across words, younger and older adults were equally familiar with the materials. Half the words were relatively familiar words and the other half were relatively low in familiarity. The other thing we did was to go on a fishing expedition. Since I had previously been successful in isolating one individual difference variable that seemed important in this situation, namely cardiovascular health status, Louanne and I thought it would be worth the effort to search for other individual difference variables that might be playing a role in the recall differences. In addition to our, by now, standard surprise free-recal test, we obtained measures on a number of other variables. These included a measure of depression, a measure of state anxiety, an index of I. Q., level of formal education, and a measure of what we called mental activity. This is an index of the extent to which a person is mentally active during a typical day. The experimental situation was essentially the same as in the earlier studies. However, we used only a single list that was equally familiar to younger and older adults.

The next slide shows the mean recall scores for the various groups. As you can see there remains a clear difference between younger and older healthy adults, even though the materials are equally familiar. You can also see

that cardiovascular health status has a small effect on performance. This time the effect occurred with both familiar and unfamiliar material. Correlational analyses of the individual difference variables produced several interesting results. Two of the variables were related to the age of the subjects. These were level of formal education and the mental activity scores. Younger adults had more formal education and higher levels of mental activity than did the older adults. In addition these two variables were significantly related to recall with higher scores on each being related to higher recall. Finally the two variables were positively related to each other. Based on these findings, one might reasonably argue that the difference in recall between younger and older adults in the present study reflects the operation of one or both of these individual difference variables. Both of them would seem to produce problems in processing efficiency rather than an actual loss of processing capacity.

The last experiment was recently completed by Brenda Estes and myself. In this study we attempted to separate the effects on recall due to years of education and level of metal activity. We did that by selecting subjects so that across groups, level of education did not vary. Mental activity, on the other hand, was allowed to vary within and between groups. Additionally in this study we added a third age group, those between 39 and 54 years of age. We called this group our middle-aged group. As with our older group,

we divided the middle-aged subjects into those with and without indications of cardiovascular disease. In this study we used only very common words from the Battig and Montague (1969) category norms.

The first issue I want to deal with is the relation of education and mental activity to recall. Our data convince me that level of formal education is the important individual difference while level of mental activity is not. By controlling level of education, we completely eliminated the correlation between recall and mental activity scores. It appears, then, that educational level is an important individual difference variable in predicting level of memory performance. The next slide shows the mean recall scores for each group. An important finding here was that among healthy adults, we did not find a statistically significant difference in recall. One way to interpret this is to suggest that we were successful in controlling all of the important causal variables. This result suggests that there is not a deficiency in processing that is a natural consequence of growing old. However I have serious reservations about saying this. Notice that among the healthy adults in this study, the mean level of recall for older adults was less than for younger adults. It is possible that there really is a reliable difference, but we have failed to detect it. In other words we may be making a type 2 error. In fact the statistical power of the test was only about .4. After a close look at the distribution of

scores in those two groups, I tend to think that there probably is a real difference. If that is true, then we are left with a small recall difference that isn't understandable in terms of word familiarity differences, cardiovascular health differences, or differences in level of education. Now I'm not sure what the variable is that could be causing the difference, but I think I know how it operates. In this study we decided to include a cued-recall test after the free-recall test. We were interested in checking out the hypothesis advanced by Perlmutter (1979). She suggested that older adults have a cue generation problem. In other words they fail to provide themselves with effective retrieval cues during free recall. If that were true, giving subjects appropriate cues during recall should eliminate the age-related recall difference. The next, and final, slide shows the results of a cued-recall test. Subjects were given the category labels and again asked to recall the words. First of all, you can see that the mean difference between younger and older healthy subjects completely disappeared. This suggests that there may be,in fact, a cue generation problem among old adults. The other interesting finding was that the cued test eliminated the cardiovascular health deficit for both middle-aged and older adults. This finding indicates that the cardiovascular health variable may also be operating to produce a cue generation problem. Right now the most parsimonious guess is that the cue generation problem is a

result of the normal aging process at work. However, that hypothesis should be taken with a large grain of salt. I would not be surprised to find important individual differences among older adults in the extent, and pervasiveness, of the cue generation problem.

In conclusion both the processing deficiency and the efficiency of processing hypotheses are alive and well in my laboratory. It seems reasonably clear that low levels of education contribute to an efficiency problem. It also makes sense to include word familiarity within the framework of efficiency rather than deficiency. It is more problematic to isolate variables in this research project clearly indicative of a deficiency in processing. However, the cue generation problem may be a processing deficiency caused by normal aging and by cardiovascular health problems.

In general, there is little doubt that age-related memory differences reflect a combination of both types of problems, inefficiency of processing and some actual loss in processing capacity. The important thing to keep in mind is that both the efficiency and deficiency problems can be associated with individual difference variables. I am now convinced that the individual difference approach is a very important one for understanding memory aging. Increasing uniqueness seems to be one of the keys to understanding life span development. Unfortunately our standard experimental mentality often causes us to think of individual differences

as simply error or noise in the system. I would suggest to you that by thinking like that we may be throwing out the baby with the bath water. A careful examination of individual differences seems to me to be one way of developing memory aging theories that reflect the complexity and variety present within the aged population.

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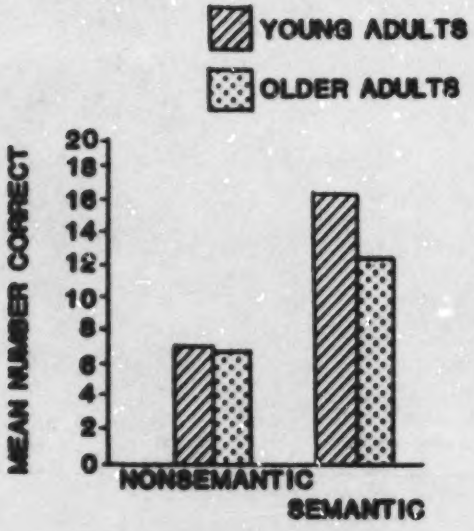
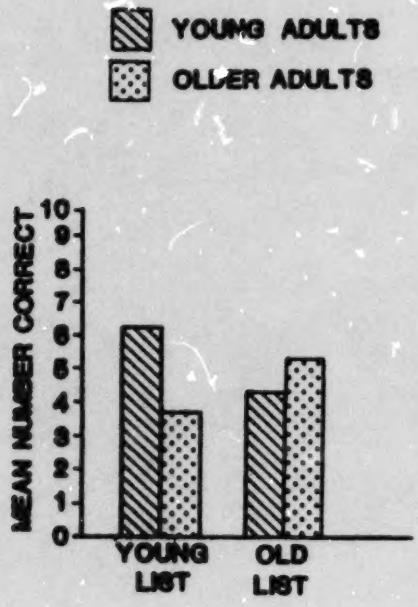
FIGURE CAPTIONS

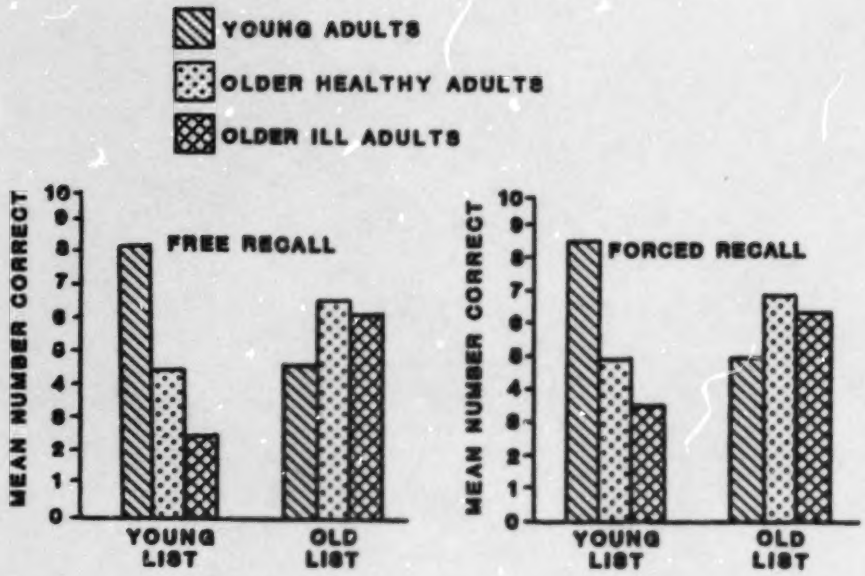
1. The results of Eysenck (1974).
2. The two lists used by Barrett and Wright.
3. Free recall results in Barrett and Wright.
4. Free and forced recall results from Barrett and Watkins.
5. Free recall results from Barrett and Yarbro.
6. Free recall results from Barrett and Brandon-Estes.
7. Cued recall results from Barrett and Brandon-Estes.

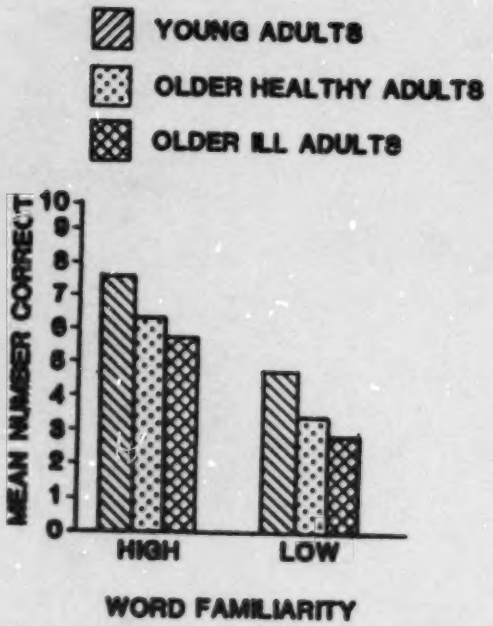


EYSENCK (1974)

Young List	Old List
Afro	Dragget
Tweeter	Poultice
Bummer	Gooseberry
Ripoff	Phaeton
Gig	Slate
Spa	Slacker
Preen	Crony
Sunspot	Counterpin
Turntable	Pantaloons
Terrarium	Pompadour
Denim	Flitters
Disco	Settee
Synthesizer	Fedora
Dude	Petticoat
Foreplay	Blotter
Cassette	Parasol
Commune	Bungalow
Narc	Teacakes
Readout	Flivver
Decoupage	Gramaphone
Reefer	Davenport
Stereo	Hollyhock
Calculator	Flapper
Bellbottom	Bolster
Gauchos	Bloomers
Pinball	Doiley
Frisbee	Victrola
Orgy	Vamp


YOUNG ADULTS
OLDER ADULTS
MEAN NUMBER CORRECT
10
9
8
7
6
5
4
3
2
1
0
YOUNG LIST
OLD LIST


YOUNG ADULTS
OLDER HEALTHY ADULTS
OLDER ILL ADULTS
MEAN NUMBER CORRECT
FREE RECALL
YOUNG LIST
OLD LIST
FORCED RECALL


YOUNG ADULTS
OLDER HEALTHY ADULTS
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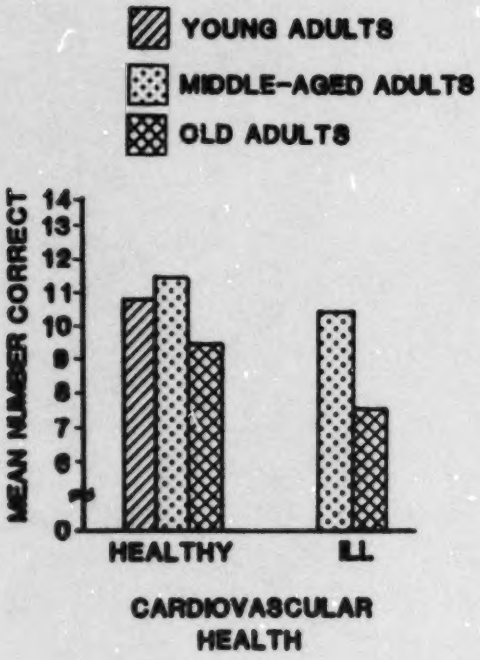
YOUNG ADULTS
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HEALTHY
ILL
CARDIOVASCULAR HEALTH